

ATTENUATORS, MATCHING PADS, TERMINATIONS AND ULTRA BROADBAND LOAD

75 mW to 1000 W, DC to 18 GHz



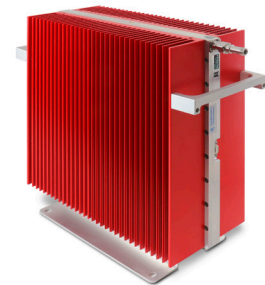
R&S®DNF
Attenuator



R&S®RDL50
High-power Attenuator



R&S®RAU
50 Ω Termination



R&S®UBL100
Ultra Broadband Load

Product Flyer
Version 10.00

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ATTENUATORS

R&S®DNF

As a rule, the reflection coefficient of commercial signal generators or test receivers is about 20 %. This value may be too high for precise measurements. To improve matching, an attenuator should be inserted after the signal generator output and another one ahead of the receiver input. This will reduce the reflection coefficients of both the generator and the receiver.

Signal generators often do not have a defined source impedance. In these cases, it is advisable to insert a 16 dB (10 dB + 6 dB) attenuator. The internal reflection coefficient of such a signal source is thus reduced to about 3 %, which is small enough for accurate measurements.

Attenuators can also be used as reference standards for attenuation and gain measurements in line with the substitution method, for precise voltage division and as buffers to isolate test circuits.

R&S®DNF (1 W/2 W)

Small attenuation error, largely frequency-independent attenuation and low VSWR are special features of the R&S®DNF attenuators. They are sturdy, immune to vibration (in line with MIL-A-3933), only slightly temperature-dependent and resistant to short-term overloading. The R&S®DNF attenuators are equipped with N connectors (male, female) and are available with 3/6/10/20 dB attenuation.



R&S®DNF

HIGH-POWER ATTENUATORS

R&S®RBU, R&S®RDL

High-power attenuators are used as dummy loads for transmitters and amplifiers in the frequency range 0 Hz to 6 GHz. Their constant attenuation enables harmonics measurements on transmitters, TV transposers and other equipment.

The high-power attenuator is superior to a simple termination. The power applied can be accurately determined from the power measured at the test output and from the known attenuation. Moreover, a frequency counter or analyzer can be connected to the test output.

R&S®RBU (50 W/100 W)

The R&S®RBU high-power attenuators with 3/6/10/20/30 dB attenuation are ideal for applications in the frequency range up to 2 GHz, which is of particular interest for mobile radio measurements. The attenuators are characterized by low VSWR and low attenuation error throughout the entire frequency range.

Due to the large heat sink, the attenuator surface temperature does not rise above +75°C (at +25°C ambient temperature) even under full load.

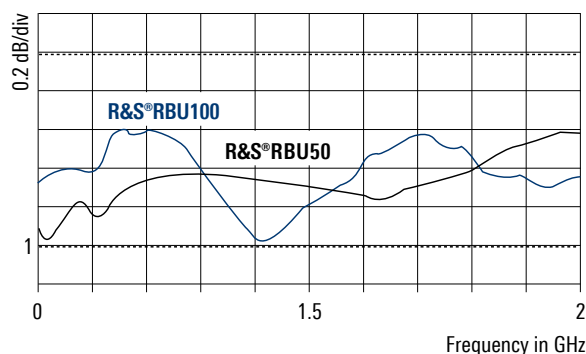
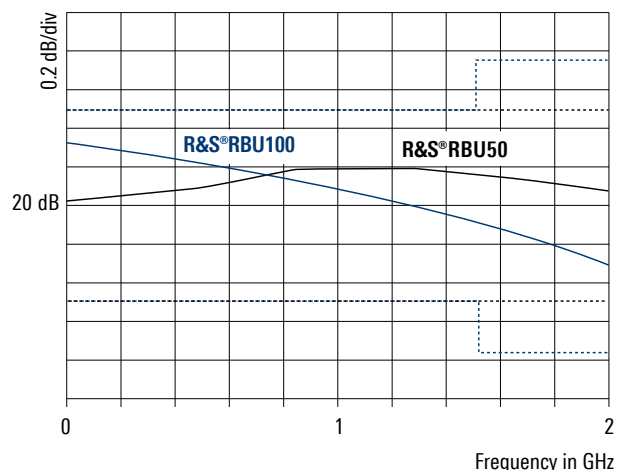
R&S®RDL50 (50 W)

The R&S®RDL50 high-power attenuator is suitable for the frequency range up to 6 GHz. A special feature is its constant low attenuation over the entire frequency range.



R&S®RDL50, 50 W

Typical characteristics of the R&S®RBU50 and R&S®RBU100 attenuators (20 dB attenuation)



TERMINATIONS

R&S®RNB, R&S®RAD, R&S®RAU

R&S®RNB (1 W)

The R&S®RNB 50 Ω termination is a versatile line termination used in type N coaxial line systems. A special feature is the very low reflection over a wide frequency range. The use of high-grade metal-film resistors provides a continuous power-handling capacity of 1 W.

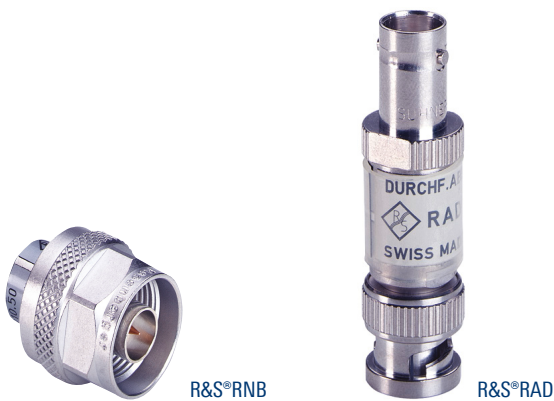
The R&S®RNB termination is for general use in the frequency range from DC to 4 GHz.

R&S®RAD (500 mW) and R&S®RAD50 (2 W) feedthrough terminations

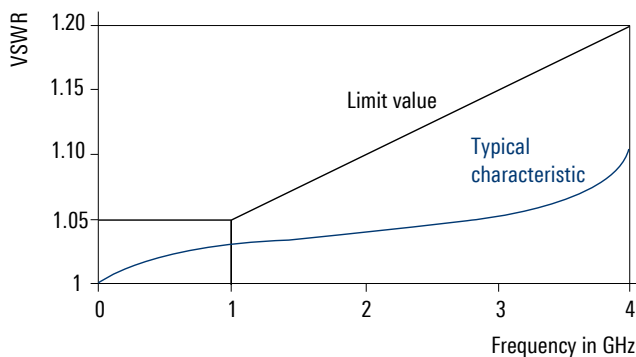
The R&S®RAD feedthrough terminations are used for matching 50 Ω lines to test and measurement instruments with high input impedance (e.g. oscilloscopes or tuners with 1 M Ω input impedance). The feedthrough termination must be plugged directly onto the input connector of the instrument to ensure optimum matching.

R&S®RAU (100 W)

The R&S®RAU termination is mainly used as a dummy antenna for mobile and stationary transmitters. Its low VSWR makes it also suitable for TV equipment.



Limit value and typical VSWR characteristic of the R&S®RNB



MATCHING PADS

R&S®RAM, R&S®RAZ

For the precise measurement of insertion loss and phase shift, the signal generator, DUT and receiver must be well matched to one another. Matching pads allow systems of different characteristic impedance to be connected without costly retrofits.

R&S®RAM and R&S®RAZ (2 W) matching pads

The bidirectional R&S®RAM matching pad provides the match between 50 Ω and 75 Ω impedance systems in both directions up to 2.7 GHz, causing minimum attenuation. Care should be taken that ports with the same characteristic impedances are connected to one another.



R&S®RAZ

Voltage transformation is defined as the ratio in dB of the voltages at the connectors:

$$A_{50\Omega \rightarrow 75\Omega} = 20 \cdot \lg \frac{U_{50\Omega}}{U_{75\Omega}} = 4 \text{ dB}$$

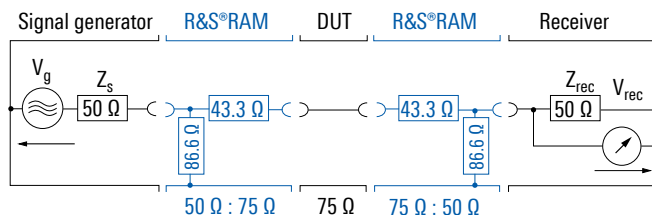
$$A_{75\Omega \rightarrow 50\Omega} = 20 \cdot \lg \frac{U_{75\Omega}}{U_{50\Omega}} = 7.5 \text{ dB}$$

Power attenuation is the same in both directions:

$$A_p = 10 \cdot \lg \frac{U_{75\Omega}^2 \cdot 50\Omega}{75\Omega \cdot U_{50\Omega}^2} = 5.72 \text{ dB}$$

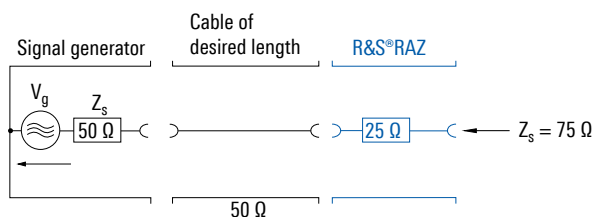
The unidirectional R&S®RAZ matching pad is particularly suitable for the matching of signal generators. In most cases, signal and sweep generators have a source impedance of 50 Ω. They can be adapted to feed 75 Ω systems by means of the R&S®RAZ matching pad involving extremely low power loss. The output voltage displayed on the generator is also valid for the 75 Ω system and does not require correction.

R&S®RAM



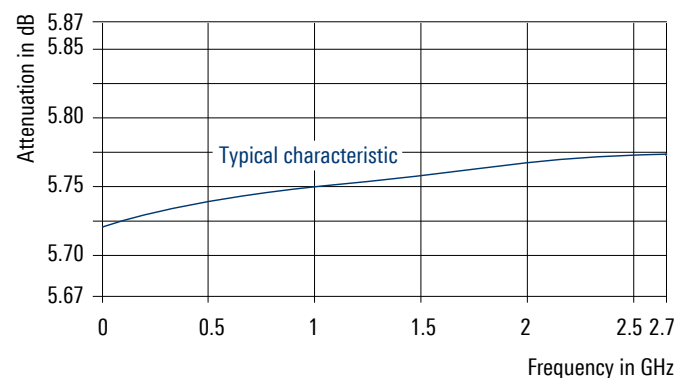
Two R&S®RAM matching pads to match a 75 Ω DUT to a signal generator and receiver, each having a characteristic impedance of 50 Ω.

R&S®RAZ



By connecting an R&S®RAZ matching pad consisting of a 25 Ω series resistor, a signal generator with a 50 Ω output has an output impedance of 75 Ω.

Frequency response and error limits of power attenuation of the R&S®RAM matching pad



OVERVIEW

ATTENUATORS, FEEDTHROUGH TERMINATIONS, TERMINATIONS

Specifications including ordering information

	Type Order No.	Characteristic impedance	Power rating	Nominal attenuation	Frequency range	VSWR
Attenuators	R&S®DNF					
	0272.4010.50	50 Ω	2 W ¹⁾	3 dB	0 Hz to 12.4 GHz	≤ 1.1 (0 Hz to 4 GHz) ≤ 1.2 (4 GHz to 10 GHz) ≤ 1.25 (10 GHz to 12.4 GHz)
	0272.4110.50			6 dB		
	0272.4210.50		1 W ¹⁾	10 dB		
	0272.4310.50			20 dB		
High-power attenuators	R&S®RBU 50					
	1073.8695.03	50 Ω	50 W ³⁾	3 dB	0 Hz to 2 GHz	≤ 1.15
	1073.8695.06			6 dB		
	1073.8695.10			10 dB		
	1073.8695.20			20 dB		
	1073.8695.30			30 dB		
	R&S®RBU 100					
	1073.8495.03	50 Ω	100 W ⁵⁾	3 dB	0 Hz to 2 GHz	≤ 1.15
	1073.8495.06			6 dB		
	1073.8495.10			10 dB		
	1073.8495.20			20 dB		
	1073.8495.30			30 dB		
	R&S®RDL 50					
1035.1700.52	50 Ω	50 W (input), 10 W (output) ¹⁾	20 dB	0 Hz to 6 GHz	≤ 1.15 (0 Hz to 2 GHz) ≤ 1.25 (2 GHz to 4 GHz) ≤ 1.4 (4 GHz to 6 GHz)	
R&S®RNB						
0272.4910.50	50 Ω	1 W ¹⁾ , 2 W (peak)		0 Hz to 4 GHz	≤ 1.05 (0 Hz to 1 GHz) ≤ 1.1 (1 GHz to 2 GHz) ≤ 1.2 (2 GHz to 4 GHz)	
Terminations	R&S®RAU					
	0200.0019.55	50 Ω	100 W ⁶⁾		0 Hz to 2 GHz	≤ 1.05 (0 Hz to 0.3 GHz) ≤ 1.1 (0.3 GHz to 1.5 GHz) ≤ 1.4 (1.5 GHz to 2 GHz)
Feedthrough terminations	R&S®RAD					
	0289.8966.00	50 Ω	500 mW ⁷⁾		0 Hz to 1 GHz	≤ 1.05 (0 Hz to 0.1 GHz) ⁸⁾ ≤ 1.1 (0.1 GHz to 0.5 GHz) ≤ 1.2 (0.5 GHz to 1 GHz)
	R&S®RAD 50					
	0844.9352.02	50 Ω ± 0.1 %	2 W ⁷⁾		0 Hz to 500 MHz	≤ 1.1 (0 Hz to 200 MHz) ⁸⁾ ≤ 1.25 (200 MHz to 500 MHz) ⁸⁾
	R&S®RAM					
Matching pads	0358.5414.02	50 Ω to 75 Ω	2 W ⁹⁾	5.72 dB	0 Hz to 2.7 GHz	≤ 1.06 (0 Hz to 2 GHz) ≤ 1.2 (2 GHz to 2.7 GHz), both terminals
	R&S®RAZ					
	0358.5714.02	50 Ω to 75 Ω	2 W ⁹⁾	1.76 dB	0 Hz to 2.7 GHz	≤ 1.06 (0 Hz to 2 GHz) ≤ 1.2 (2 GHz to 2.7 GHz), at 75 Ω end
0358.5714.03	0 Hz to 3.3 GHz				≤ 1.06 (0 Hz to 2 GHz) ≤ 1.2 (2 GHz to 3.3 GHz), at 75 Ω end	

¹⁾ At a max. ambient temperature of +30°C; decreasing linearly to 0 W at +130°C (R&S®RDL50: +125°C).

²⁾ Attenuation change at a temperature change of 1 °K: ≤ 0.0001 dB/dB. At a load change of 1 W: ≤ 0.001 dB/dB.

³⁾ Input overload capacity up to 150 W at +20°C ambient temperature (max. 10 min); output overload capacity up to 20 W.

⁴⁾ Attenuation change at a temperature change of 1 °K: ≤ 0.0004 dB/dB. At a load change of 1 W: ≤ 0.0001 dB/dB.

⁵⁾ Input overload capacity up to 250 W at +20°C ambient temperature (max. 10 min); output overload capacity up to 20 W.

⁶⁾ Overload capacity 100% (max. 5 s).

⁷⁾ Continuous power rating up to a maximum ambient temperature of +70°C; decreasing linearly to 0 W at +130°C.

⁸⁾ Measured with open-circuit output.

⁹⁾ Ambient temperature +25°C.

ATIONS, MATCHING PADS

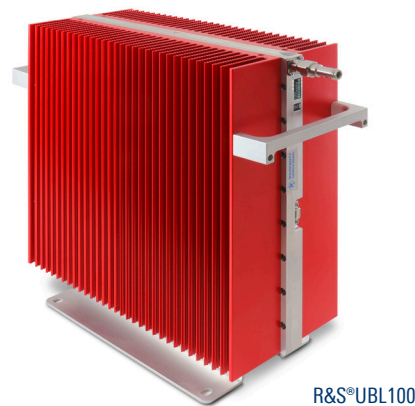
	Attenuation (N = nominal value)	Max. peak pulse voltage	Connectors	Dimensions, weight
	N ± 0.3 dB (0 Hz to 8 GHz) ²⁾ N ± 0.5 dB (8 GHz to 12.4 GHz) ²⁾ N ± 0.3 dB (0 Hz to 8 GHz) ²⁾ N ± 0.6 dB (8 GHz to 12.4 GHz) ²⁾ N ± 0.5 dB (0 Hz to 4 GHz) ²⁾ N ± 0.6 dB (4 GHz to 8 GHz) ²⁾ N ± 0.8 dB (8 GHz to 12.4 GHz) ²⁾		N male, N female	20.5 mm Ø × 55 mm, 69 g
	N ± 0.6 dB (0 Hz to 1.5 GHz) ⁴⁾ N ± 0.85 dB (1.5 GHz to 2 GHz) ⁴⁾ N ± 1.1 dB ⁴⁾	5 kW/5 µs	N male, N female	180 mm × 77 mm × 90 mm, 0.8 kg
	N ± 0.6 dB (0 Hz to 1.5 GHz) ⁴⁾ N ± 0.85 dB (1.5 GHz to 2 GHz) ⁴⁾ N ± 1.1 dB ⁴⁾	5 kW/5 µs	N male, N female	236 mm × 140 mm × 141 mm, 2.8 kg
	N ± 0.5 dB	2 kW/5 µs	N male, N female	114 mm × 89 mm × 68 mm, 0.5 kg
			N male	20.5 mm Ø × 35 mm, 36 g
		2 kV	N female	95 mm × 152 mm × 235 mm, 2 kg
			BNC male, BNC female	14.5 mm Ø × 50.5 mm, 22 g
			BNC male, BNC female	15.3 mm Ø × 50.5 mm, 22 g
	5.72 dB + 0.15/- 0.05 dB		N male, N female at 75 Ω end	21 mm Ø × 73 mm, 105 g
	1.76 dB ± 0.2 dB		N male, N female at 75 Ω end	21 mm Ø × 73 mm, 105 g

ULTRA BROADBAND LOAD

R&S®UBL100

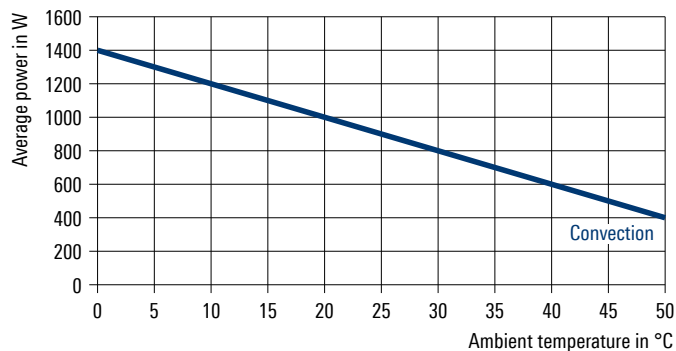
The R&S®UBL100 is an ultra broadband load that can be used from DC to 18 GHz.

The dummy load absorbs RF power and dissipates it through convection cooling. An optional fan unit improves heat dissipation. A built-in interlock loop can be used to switch off the device feeding the load when the heatsink temperature rises above +70°C. Unlike cable loads, there is no lower frequency limit. The R&S®UBL100 can absorb up to 1800 W.

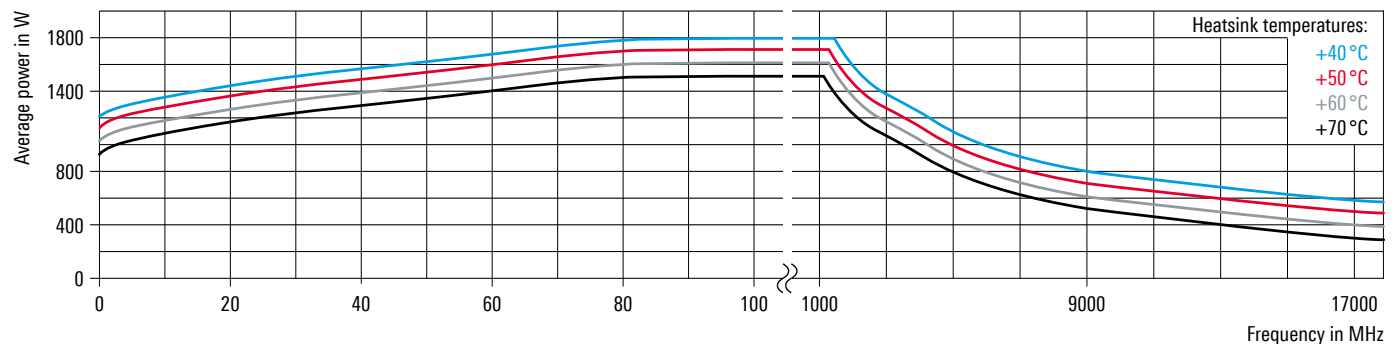


Maximum permissible average power as a function of ambient temperature

Maximum average power with convection cooling for +70°C heatsink temperature



Maximum permissible average power as a function of frequency and heatsink temperature



Key facts

- ▶ Very good return loss, especially up to 6 GHz
- ▶ High power capability
- ▶ Very rugged for short-term overload
- ▶ High crest factor capability
- ▶ Easy handling with optional caster wheels

Power handling capability

The first diagram shows the derating of the load for convection cooling due to the limited ability of the heatsink to dissipate the absorbed energy for a given ambient temperature and maximum heatsink temperature of +70°C. The heatsink temperature reaches a stable value after more than one hour of continuous operation of the load.

The second diagram describes the maximum permissible input power in Watt due to the limits of the internal circuitry of the load. The derating is a function of the heatsink temperature. Between 80 MHz and 1000 MHz, the value for the maximum input power is constant. To prevent damage, the specified maximum average input power for a heatsink temperature of +70°C must not be exceeded.

When the optional fan unit is used, only the second diagram is relevant. In the case of convection cooling, both diagrams need to be taken into account, and the diagram giving the lower limit defines the maximum permissible input CW power for a certain frequency and ambient temperature.

Specifications R&S®UBL100		
Frequency range		DC to 18 GHz
Input impedance		50 Ω
Input connector		4.3-10 female, adapter to N included
Input VSWR (including N adapter)	$f \leq 2 \text{ GHz}$	≤ 1.15
	$2 \text{ GHz} < f \leq 6 \text{ GHz}$	≤ 1.25
	$6 \text{ GHz} < f \leq 18 \text{ GHz}$	typ. ≤ 1.50 , max. 2.25 possible at a few discrete frequencies
Average input power P_{avg} ¹⁾	$f \leq 80 \text{ MHz}$	derating, see diagrams on page 8
	$80 \text{ MHz} < f \leq 1.0 \text{ GHz}$	up to 1800 W with fan unit, see diagrams on page 8
	$f > 1.0 \text{ GHz}$	derating, see diagrams on page 8
Crest factor for OFDM	bandwidth $> 1 \text{ MHz}$	$\leq 12 \text{ dB}$
Peak power (duty cycle $< 1\%$)	$f \leq 650 \text{ MHz}$, $< 100 \mu\text{s}$ pulse width	$\leq 15 \text{ kW}$
	$f > 650 \text{ MHz}$, $< 1 \text{ ms}$ pulse width	$\leq 15 \text{ kW}$
Maximum heatsink temperature	surface, near the interlock connector	$\leq +70^\circ\text{C}$
Typical heatsink temperature T_{hs}	at $+20^\circ\text{C}$ ambient temperature and 1000 W average power	<ul style="list-style-type: none"> ▶ $+70^\circ\text{C}$ for convection cooling, see user manual ▶ $+33^\circ\text{C}$ with optional fan unit, see user manual
Temperature protection		thermoswitch for external interlock loop, normally closed, opens at $> +70^\circ\text{C}$
Interlock loop connector (thermoswitch)		D-Sub, 9-pin female, pin 1 and pin 5
Thermoswitch rating	voltage to ground, pin to pin	$\leq 50 \text{ V}$
	current	$\leq 1 \text{ A}$
Cooling		convection cooling, optional fan unit
General data		
Dimensions (W × H × D)	including handles and feet	492 mm × 480 mm × 198 mm (19.4 in × 18.9 in × 7.8 in)
Weight		45 kg (99.2 lb)
Fan unit		
Operating voltage range		85 V to 264 V AC, 47 Hz to 63 Hz
Rated current		$\leq 0.9 \text{ A}$
Noise emission	in typical lab environment	approx. 77.5 dB(A)
Environmental conditions		
Temperature ranges		
Minimum operating temperature (ambient)	ultra broadband load and fan unit	$+5^\circ\text{C}$
Maximum operating temperature (ambient)	ultra broadband load	see derating curve for average power versus ambient temperature on page 2
	fan unit	$+45^\circ\text{C}$
Maximum operating temperature (air inlet)	fan unit	$+60^\circ\text{C}$
Storage temperature range	ultra broadband load and fan unit	-40°C to $+80^\circ\text{C}$
Damp heat	ultra broadband load	$\leq 95\%$ noncondensing
	fan unit	$\leq 90\%$ noncondensing
Operation above sea level	ultra broadband load and fan unit	2000 m
Transportation above sea level	ultra broadband load and fan unit	4600 m

¹⁾ Depends on input power and exposure time; $+70^\circ\text{C}$ surface temperature must not be exceeded.

Ordering information R&S®UBL100		
Designation	Type	Order No.
Ultra broadband load	R&S®UBL100	5355.6105.02
Ultra broadband load, with fan unit, on caster wheels	R&S®UBL100	5355.6105.22
Ultra broadband load, with fan unit	R&S®UBL100	5355.6105.32
Ultra broadband load, on caster wheels	R&S®UBL100	5355.6105.42